Ninth Edition

The Review of Technical Paints

NINTH EDITION

The REVIEW *of* Technical Paints

By

FRANK P. CHEESMAN

Member

N. Y. Railroad Club
Society of Chemical Industry
American Society for Testing Material
National Paint Oil & Varnish Association
Paint Manufacturers' Association of the U. S.

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CHEESMAN & ELLIOT

TECHNICAL PAINT MAKERS

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NATIONAL PAINT WORKS

WORKS

WILLIAMSPORT, PA. BROOKLYN, N. Y.

MAIN OFFICE

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GARDEN PIER, ATLANTIC CITY, N. J.

Erected 1913. Simon & Bassett, Philadelphia, Architects. No. 31 Red Oxide used for shop and first field coat. No. 16 Carbon Black used for second field coat on all structural steel of this pier.

FOREWORD

IN 1876 William G. Elliot founded the National Paint Works at Williamsport, Pa.

He believed that the only way to obtain the best painting results was to first study the climatic and other conditions to which a paint was to be subjected, and then make the paint to suit the work.

Forty years have seen many improvements in the manufacture of paint. New problems have arisen which demanded new solutions, but the basic idea which more than any other factor has given the firm of Cheesman & Elliot the position it now holds, has not changed.

Six years after the foundation of the firm, the business had increased sufficiently to necessitate a partner. William H. Loomis, then in a sales capacity, was made a partner.

That partnership continued until 1903, when Frank P. Cheesman, who had been identified for nearly twenty years with two leading houses in the paint and varnish trade, bought the interests of Mr. Loomis.

Two years later Mr. Elliot died and was succeeded by his son Norman Elliot. Ever increasing business demanded greater productions and made necessary many changes. The main office was moved to New York. The capacity of the Williamsport plant was doubled in size and in 1912 a new factory was opened in Brooklyn, larger in capacity than the Williamsport plant, and both are now being operated.

Our object in issuing the Ninth Review of Technical Paints is to give our customers, and others interested, the benefit of our years of experience, together with authentic paint information. Any statements contained in this book may be considered absolutely authoritative.

Everything we produce is custom made, thus insuring fresh stock and individual attention to each order. A large amount of raw material is constantly on hand, and we guarantee shipment within twenty-four working hours of an order's receipt.

The test of time has proven the idea which has contributed so largely to our success to be a fact. In 1915, as in 1876, the main plank in our sales platform is: "To obtain the best painting results the paint must be manufactured in accordance with the special requirements of the work."

CHEESMAN & ELLIOT

Please Read Before Ordering.

An inquiry regarding any of our products, price list, color cards, or a request for information or advice will receive prompt attention if addressed to Cheesman & Elliot, 100 William Street, New York City. Our Mr. Cheesman gives his personal attention to all such requests.

We do not carry stock made up, but manufacture everything to order. Shipment is guaranteed within twenty-four working hours after your order is received, and as a rule, we will ship within twelve hours.

If you cannot find a satisfactory shade on our color cards, send us a sample showing shade desired and we will match it exactly.

When writing us relative to an order, give all possible information

Tell us—

What is to be painted? (Galvanized iron, steel, tin, brick, copper, wood, etc.)

How many coats are you going to apply?

How much time will you allow for drying between coats?

If painted before, what was used, and what is its condition now?

What kind of exposure? (Sun, water, gases, etc.)

How is it to be applied? (Brushed, dipped or sprayed.)

PAINTING FACTS.

More paint is spoiled in the application than from any other cause. A package of paint should be well stirred before using. Remove head of package and mix thoroughly with a broad, flat paddle. A round, medium-sized brush is far superior to a broad, flat brush. In cold weather, ten to twenty per cent. more paint is needed to cover a surface than in a temperature of from sixty to seventy-five degrees. Cutting down the proper time for drying is lessening durability. Be sure the paint is dry before applying second coat. Brush out well. Two thin coats are better than one thick coat.

Paint Specifications.

For the general guidance of engineers, architects, and others, the following specifications are recommended as the best for certain general classes of work. If unusual conditions are to be met, it would be best to advise us concerning them in detail, so that we can make recommendations to meet the special requirements.

SPECIFICATION NO. 1.

BRIDGE AND STRUCTURAL STEEL, CORRUGATED IRON, ETC.

Cleaning of Metal.—No paint to be applied until the metal has been carefully and thoroughly cleaned of all mill scale, rust, dirt, grease or other foreign substances, and the metal must be absolutely free from moisture.

Shop Coat.—Immediately after the metal has been cleaned, and while still bright, the first coat of paint shall be carefully applied, and shall consist of Cheesman & Elliot's No. 31 RED OXIDE. This coat shall be thoroughly brushed into the pores of the metal with suitable brushes, not over 4 inches in width, with stiff bristles.

Field Coats.—The first field coat shall be Cheesman & Elliot's No. 54 OXIDE & GRAPHITE, and shall be applied after the erection of the steel. The finishing coat shall be Cheesman & Elliot's No. 16 CARBON BLACK. (If only one field coat is to be applied, use No. 16.)

General Conditions.—No coat of paint shall be applied until the previous coat is thoroughly dry and hard, and in no case shall any painting be done until at least five days have elapsed since the application of the previous coat.

No painting shall be done during wet or foggy weather.

All paint shall be purchased direct from the manufacturer and delivered to the work in original sealed packages. Paint must be kept thoroughly stirred to an even consistency, and no thinning to be allowed except by the addition of pure linseed oil, and only on approval of the engineer.

SPECIFICATION NO. 2.

STRUCTURAL STEEL TO BE ENCLOSED IN CONCRETE, ETC.

Cleaning of Metal.—(Same as in Specification No. 1.)

Shop Coat.—(Same as in Specification No. 1.)

Final Coat.—The final coat shall be applied after erection and shall consist of Cheesman & Elliot's No. 755 SUBWAY BLACK, applied as received from the manufacturer without thinning of any kind.

General Conditions.—(Same as in Specification No. 1, except as applied to thinning.)

SPECIFICATION NO. 3.

GALVANIZED IRON.

Cleaning.—All dirt and dust shall be carefully brushed off the metal.

First Coat.—Immediately after the metal has been cleaned, the first coat of paint shall be applied, and shall consist of Cheesman & Elliot's No. 625 GALVANIZED IRON PRIMER. No thinning of any kind shall be done to this paint. (Note.—On account of the gums used in this paint very cold weather may cause it to thicken. In such a case, if necessary to paint in cold weather, pure spirits of turpentine may be added to the paint in order to secure proper spreading. But thinning should not be done unless absolutely necessary.)

Finishing Coats.—No. 16 CARBON BLACK or any of our Standard Paints may be used successfully over No. 625 GALVANIZED IRON PRIMER.

General Conditions.—(Same as in Specification No. 1, except as applied to thinning.)

SPECIFICATION NO. 4.

INTERIOR WALLS, CEILINGS, ETC.

For a Durable, Flat, White, Washable Finish.—Use one or two coats (according to kind of surface) of Cheesman & Elliot's No. 57 NaPaWork INSIDE FLAT WHITE, allowing sufficient time between coats for thorough drying. It is suitable for brick, concrete, plaster, wood or metal, and we recommend that when used over metal, a priming coat of No. 31 RED OXIDE should first be applied.

For a Durable, Flat, Washable Finish in Colors.—Use one or two coats (according to kind of surface) of Cheesman & Elliot's NaPaWork INSIDE FLAT FINISH in the color selected. These finishes are furnished in all shades and tints.

For a Durable, Gloss, White, Washable Finish.—Use one or two coats of Cheesman & Elliot's No. 57 NaPaWork INSIDE FLAT WHITE, followed by a coat of Cheesman & Elliot's "SunWite" ENAMEL, allowing sufficient drying time between coats. This will produce an excellent and lasting white finish.

THE AUTHOR.

The Review of Technical Paints.

A greater advance has been made in technical paint knowledge during the last ten years than ever before in the history of the trade. This has been due largely to the experiments conducted under the auspices of the various associations, such as the Paint Manufacturers, the American Society for Testing Materials, the Society of Chemical Industry and others.

The use of structural iron for the erection of buildings is of a comparative recent date, as the first building erected in the United States with iron girders and joists was the Bank of the State of New York, built in New York City about 1850. It has been within the past twenty-five years that structural steel has come into general use for the erection of large buildings. The quality and construction of structural iron or steel used today is quite different from that originally used, and this has necessitated a change in the composition of paints suitable for use on structural metal.

It would seem that the large consumers of paint, as well as many of the paint makers, have at last been brought around to our point of view, and they now recognize that the policy we have followed during forty years, of making the paint to order and changing the formula to suit the climate, surface, exposure, etc., is a scientific and technical method of manufacturing paints to secure the best results.

In the 1904 edition of our Review of Technical Paints we stated:

"The manufacturer should also know the conditions under which his paint is to be used, otherwise perfect results in some locations will prove a failure elsewhere. He should know the climatic conditions, whether it will be a rush job, or whether proper time will be allowed between coats, will skilled workmen be employed or poor ones, and how many coats are to be applied? In solving these questions, you can see how much more valuable service can be rendered by a manufacturer like ourselves, which makes up the paint especially for each order so as to be suitable for these different requirements. This is where our success as regards durability has mainly been derived from."

The above is just as true in 1915 as it was when written in 1904.

We have also claimed for over thirty-five years that a combination paint, made from two or more selected pigments, is superior in durability to a single pigment paint, and we quote from our Review, published in 1896, copies of which are on file at our New York office:

"Too much of anything is not so good as just enough. For instance, White Lead is improved and made much better and more durable by adding a proper proportion of zinc. Oxide of iron can be reduced in amount of sesqui-oxide and the paint improved and cost reduced. Dr. C. B. Dudley reduced the amount of sesqui-oxide in P. R. R. Standard specifications from 50 to 25 per cent., and increased the amount of inert material. Numerous engineers think that the oxides of iron that run from 80 to 95 per cent of iron are the best. This is not a fact. We have secured better results by reducing the oxide."

The above statement has been approved by the Scientific Section of the Paint Manufacturers' Association, who have spent thousands of dollars in field tests, and we refer to their booklets, especially bulletins numbers 26, 27 and 28, as confirming largely our views and statements made many years before the Paint Manufacturers' Association was even organized.

We quote from a paper read before the Soc. of Chem. Industry, written by the chief chemist of a prominent lead company:

There is not, in my opinion, any pigment which for general work gives the best results when used alone.

Straight zinc oxide is too fine and makes a very poor coat.

Sublimed white lead is also too fine.

Lead carbonate is chemically too unstable.

And so through the entire list of paint-making materials, no lead for each substance certain deficiencies which can be remedied by addition of other ingredients possessing the particular characteristic desired.

If it appears from the above I have laid on this property of fineness that I consider it in any sense a deficiency, I will say that this is very far from being the case. The finer the better as we invariably rule for the smallest proportion of coarser particles, as we embodied advantage of having present a minor proportion of coarser particles.

The selection of the particular type of coarse particle is a matter for the judgment of the paint compounder, but it is worth notice that those mixtures which are generally given the best service are characterized by the presence of a crystalline constituent of sharp angularity and chemical stability.

Elasticity is an important feature in the durability of a paint for metal, and this depends more upon the vehicle than the pigment; therefore a proper combination of the two is required.

Covering power is an important item to be considered. This is used to designate two different properties of a paint, hence must be definitely expressed. First, covering power means the amount of surface which a gallon of paint will cover with a given number of coats. Second, covering power means the density of a paint, as, for instance, it will take four coats of white lead to cover up a surface that two coats of iron oxide paint will hide or cover equally as well. In order to distinguish these two we will call the first, Spreading Power, and the second, Hiding Power.

Spreading Power.—The spreading power of a mixed paint is dependent upon its viscosity. The thinner the paint the more surface it will cover and the film of paint will also be thinner, hence it is the vehicle or liquid in the paint which gives the spreading power.

It is therefore ridiculous, as well as false, to claim that a paint made with linseed oil as a vehicle can spread as much or more than a gallon of linseed oil will cover without any pigment in it. It is a well-known rule that for every pound of pigment added to the vehicle you must subtract spreading power. Approximately one gallon (7.69 lbs.) of raw linseed oil will spread over 350 square feet of dry soft wood (absorbent surface), over 650 square feet of hard wood (semi-absorbent), and about 1200 square feet of steel (non-absorbent surface).

Careless spreading of paint will cause a lack of uniformity of thickness of a coating, so that in any case the attainment of an average estimate of thickness cannot be depended upon. When, however, a paint is advertised to cover 1000 square feet to the gallon it means necessarily that the coating must average less than 1-670 inch thick, which may be compared with thin tissue paper.

A basis whereby deductions may be made to approximate the average thickness of a coat of paint on a smooth flat surface, which does not absorb any of the paint, may be readily calculated in the following manner:

A legal standard United States gallon contains 231 cubic inches, and if one gallon of paint is spread over a surface containing 231 square feet, the wet paint will average 1-144 inch thick. In like manner, should the paint be spread twice as far and cover 462 square feet to the gallon, the thickness would be 1-288 inch, which can be compared to the thickness of the leaves of a book having 288 pages to the inch.

Carbon paints, like our No. 60, have a spreading power for one coat on metal of about 850 square feet, graphite about 800, oxide of iron and blue lead paints about 650, white lead about 550, red lead about 500. These figures only apply when the paint is applied to a surface properly prepared and at a temperature of not below 60 degrees; at a lower temperature they will cover from 10 to 25 per cent less surface.

In the 1912 report of the American Society for Testing Material, the Inspection Committee on the Havre de Grace Bridge Paint states that the four paints in Class C which received the highest mark, the spreading power of three of them was 800 square feet and the other was 900. This supports our statement that there is a limit to the proper spreading power of a paint, and that limit we reach with No. 600. When

you go beyond 850 square feet per gallon spreading power, you are doing it at the expense of durability, as it has been clearly proven that the most durable paints are those which contain a large percentage of pigment to the square inch of surface, and it is only because carbon black is the finest and bulkiest pigment we can use, that we get such a large spreading power without injury to durability.

The vehicle is the weak link of the paint chain, and the pigment which best protects the vehicle, or liquid portion of the paint the longest from decay, makes the best paint; when you reduce the amount of pigment, as a rule it increases your spreading power, but when you reduce it so greatly as to not properly protect your vehicle from decay then you sacrifice durability for spreading power.

The finer a pigment is ground both in dry and paste form the greater your durability, because it surrounds the vehicle closer and therefore protects it better. Fine grinding also increases your spreading power, and this explains why we can give at least 15 per cent. greater spreading power and durability with up-to-date machine mixed paints than can be obtained from hand mixed. It is also a good plan to dry mix some pigments before adding the vehicles, as they can be more intimately combined dry than wet.

Hiding Power.—When a hard, thick surface is desired we must use a high percentage of pigment, and where elasticity is the first consideration we must use a large percentage of non-volatile vehicle, and secure proper thickness by an increased number of coatings.

WHAT CAUSES PAINT TO DECAY?

1. Poor Surface and Improper Application.
2. Sun.
3. Moisture.
4. Mechanical Injury, Abrasions, Expansion and Contraction.
5. Deleterious Gases.
6. Electrolysis.
7. Peeling.
8. Heat.

1. Poor Surface and Improper Application.

As before stated, more paint is ruined by improper application than in any other way; hence, we class it as the greatest cause for the failure of paint. It has been our experience that not once in fifty times is the surface entirely free from corrosion, mill-scale, grease and dirt when the paint is applied. The metal painter is usually not skilled in the art of painting, and the paint is applied under various degrees of temperature and

moisture, often rained, frosted or snowed on before dry, also frequently thinned with cheap, worthless oils and japans, and it is a wonder that under these conditions, it stands as well as it does.

The character of the surface on which paint is applied has a great influence on the durability of the coating.

If the steel is rolled cold or nearly cold the scale will come off much quicker and easier than if it is rolled hot; when rolled hot the scale is pressed in and takes many months frequently before working free, then it carries the paint with it.

Pickling the metal at the mill was formerly considered the best method for removing mill-scale, but it would now seem that the sand-blast is better. It costs from $1.00 to $2.00 per ton for pickling, and from 80 cents to $2.00 per ton for sand-blasting. When the metal is not cleaned at the mill to obtain the greatest durability on work that can be reached to be cleaned off, it would be best to apply only a shop coat of our No. 51 Red Oxide, then after this is allowed to stand from six months to a year depending upon whether the steel was hot or cold rolled, this first coating should be completely removed by burning off with the painter's torch, then give the metal a coat of linseed. This is our first choice as it removes the moisture as well as the scale. Sand-blasting is a second choice of with wire brushes, which, however, do not do the work as well as it should be done. After cleaning, two, or better still, three coats of paint should be applied, the kind of paint depending on location, climate and condition of exposure.

We regret to say, however, that we do not believe that this latter method of properly preparing the surface will be followed by many as they will think it rather expensive, and yet it would prove itself the cheapest in the long run.

One thing must be remembered, however, and we quote Mr. Emil Swensson, M. Am. Soc. C. E., as one of the best authorities on this, and that is:

"That on some steel it is impossible to get anything that will stand, as the steel will eat up and destroy any protective coating that can be applied, but the steel that signals so will go to pieces one structure will go to pieces one another simply due to this cause, and it should not be blamed for its 'quick deterioration.'"

The following extract is from a paper read by G. W. Thompson before the Amer. Inst. of Chemical Engineers June 22, 1910:

"By corrosion of iron and steel we refer to the oxidation which takes place at ordinary temperature, with the formation of rust. Rust approximates the following formula:—

$$Fe_2O_3 \cdot 3H_2O.$$

although all rust does not exactly conform to this formula.

"A sample of rust, obtained by exposing a thoroughly cleaned piece of steel that is a steel which had been pickled to remove scale, etc., analyzed as follows:—

	Per Cent
Hygroscopic moisture	9.32
Combined water (including CO_2 5.17 per cent)	27.43
Ferric oxide (equivalent to iron 48.88 per cent)	69.83
Silica	.36
	98.94

The ratio between the combined water and the ferric oxide corresponds approximately to the chemical formula given.

It is to be noted, however, that, in addition to what is known as the combined water, it contains a relatively large amount of hygroscopic water. The nearly 9 per cent. of hygroscopic water shown in the above analysis corresponds to nearly 30 per cent. of water by volume.

A very important consideration in connection with the formation of rust is this: The specific gravity of iron is about 8.70, and the specific gravity of rust is about 3.70. If the iron and the rust are strictly pure and of theoretical composition the iron shows an increase in volume in conversion to rust equal to 336 per cent.; that is, 100 parts of iron becomes 436 parts of rust by volume.

Rust often has associated with it the mill scale, which is formed in the process of rolling or other hot treatment, this scale consisting of slag and oxides of iron, more or less similar to magnetic oxide.

If we consider a rusting surface together with its atmospheric surroundings as a material system, corrosion may be due to forces operating within that system or to forces coming from without the system such as straight electric currents. Corrosion of the former kind should be considered as primary corrosion and the latter kind secondary corrosion. Primary corrosion may also be considered as autogenous. In the terms of the electrolytic theory of corrosion primary corrosion is due to primary or autogenous electrolysis, while secondary corrosion is due to secondary electrolysis.

The prime material factors in corrosion are air and moisture, and the action of air and moisture is accelerated or retarded by other factors.

There can be no question but that iron and steel should be as thoroughly cleaned at the shop as possible. We have a feeling that more attention at some time in the future will be given to this phase of the subject, and that the producers of steel will work towards the production of a polished surface.

It is desirable that each coat of paint have a distinct color, so that the painting can be inspected and imperfections in the workmanship observed. For this reason it is not wise to select paints for all coats of exactly the same composition. By far the greater part of the failure in the protection of iron and steel by the application of paint is due to poor workmanship, and from this standpoint alone the selection of the color of each paint coating is an important matter. The use of linseed oil as a priming coat is to be condemned.

2. Sun.

It is easier to make a paint to stand underground, or under water exposure, than sun exposure with its different degrees of heat, causing expansion and contraction, and also drying up the vehicle which furnishes binding and elastic qualities to the paint.

A paint which contains bitumen or asphaltum as its leading pigment should not be used where exposed to the sun.

The ability of certain pigments to absorb, and of other pigments to prevent the passage of ultra-violet rays no doubt has some bearing upon their action in a paint. The reflection of light by white paints might tend to preserve any delicate colors underneath them, while black paints have the contrary effect. Black pigments, such as lampblack and carbon black, are very slow driers, and tend to form films with linseed oil, which are for some period excellent excluders, remaining quite elastic and durable. The chemical and heat rays of the sun, absorbed according to the selective action of the pigment, undoubtedly have some effect upon the drying and longevity of the oil.

A dark colored paint, other things being equal, stands weather better than white paint, because it does not allow the penetration of the actinic rays to which a great deal of destruction is due.

In tropical countries a bright orange yellow shade, like our No. 214 Florida East Coast R. R. Yellow, seems to be the most durable for a finishing coat, provided high grade pigments are used in producing the shade.

3. Moisture.

Rain water carries quite a percentage of ammonia and oxygen and these destroy paint. If the surface to which the paint is applied is wet, it will cause the paint to peel and blister; if the paint is rained on before dry, it will absorb a percentage of moisture that will give trouble later on. A paint that is alternately wet and dry will not last as long as one that is either wet or dry at all times. Hail, snow and ice, thawing and freezing, rain and its evaporation, attack vigorously the organic properties of the vehicle in a paint.

4. Mechanical Injuries.

Under this heading we can class abrasions, strains due to wind pressure, passage of trains, etc., and expansion and contraction due to temperature changes.

5. Deleterious Gases, Acids, Etc.

Sulphureted hydrogen, ammonia, sulphurous, carbonic and nitric acids and other fumes are active promoters of corrosion. Salt brine from refrigerator cars and sulphur water from coal cars are very destructive to railway bridges. We recommend our No. 31 Williamsport Red Oxide for salt brine exposure, on bridges, and our No. 1625 Acid Proof Black Paint for acid exposure.

6. Electrolysis.

This, as defined now, is chemical decomposition effected by means of an electric current. The current on its return from its work to its generating source will come by the shortest and best circuit. If its own conductor does not furnish this, then the current will jump to a better circuit, and on the new route wherever it leaves the metal another jump will occur and corrosion will take place there and not where the current entered. Paints under fancy names are extensively advertised as being absolute proof against electrolysis. Such statements are misleading; some pigments are partially non-electric and stand better than others but none gives perfect protection. The best pigment is lampblack in combination with fossil and high-grade asphaltum gums. Our No. 600 Black Metal Protector, which is made along these lines, is the best for use on underground work exposed to electrolysis, especially when applied over a shop coat of our No. 31 Williamsport Red Oxide.

7. Peeling.

There is a great difference in paints as to their power to adhere to various surfaces; hence, it is necessary to know what kind of a surface it is before recommending the particular kind of paint to use. If several coats of paint are applied before each coat is thoroughly dry, the paint

will peel. If the surface is wet when painted, or a sudden change of temperature takes place before the paint is hard, peeling may result. Galvanized iron and zinc are some of the worst surfaces on which to make a paint adhere. On new galvanized ironwork, the acid left on the surface will attack a paint, the principal vehicle of which is linseed oil, and cause it to peel. Also, the greasy nature of these metals and their hard, smooth surfaces do not afford a secure hold for linseed oil paints. To obtain good results in painting galvanized iron, it has been necessary to manufacture a special paint for the priming coat, and for this purpose we recommend our No. 625 GALVANIZED IRON PRIMER, which is described elsewhere.

8. Heat.

Exposure to heat takes in those conditions where heat is produced by artificial means. This heat may come in contact with paint exposed to outside or inside atmospheres. The class of structures subject to the former includes smokestacks, blast furnaces, locomotive front ends, etc., and the class subject to the latter includes boiler fronts, furnace fronts and hot air and steam pipes. In all such cases the maximum amount of temperature should be ascertained, and if found to be more than the boiling point of water (212 degrees F.), a compound vehicle will be necessary. Should the heat run over 600 degrees F., little or no linseed oil should be used. Red heat of steel or iron is over 900 degrees F., and the author knows of no vehicle that will stand this heat and be waterproof and rust preventing at the same time. We manufacture several different kinds of Smokestack Paints, Locomotive Front End Paint, etc. Try our No. 750 Smoke Stack Black.

PIGMENTS AND VEHICLES.

With but possibly one exception (red lead) the old-time pigments have more than held their own, and while we propose to continue testing everything new that is offered as an improvement on the old, we will not advocate the use of a new pigment or vehicle until we have tested it under all possible conditions.

A service test is the only reliable test. Laboratory, small metal plates, and short time tests are frequently very misleading, and we can give many instances to prove this.

The pigments which are recognized generally as being the standards for use on metal surfaces, either separately or in combination, are as follows: Carbon Black, Red Oxide of Iron, Brown Oxide of Iron, Blue Lead, Red Lead, White Lead, Graphite, Magnetic Black Oxide and Zinc.

In vehicles, Linseed Oil, Treated China Wood Oil, Turpentine, Varnishes and Driers are the best for grinding, thinning and drying purposes.

All of the above pigments and vehicles have their value and use, but it takes experience, care and skill to make a satisfactory protective coating from any of them.

The fact is frequently overlooked that the first coat of paint is a great factor towards increasing or decreasing the durability of the succeeding coats. There is no doubt but that it is just as necessary to get the proper foundation for your paint as for your buildings. When this fact is more generally appreciated, our burden as Paint Specialists will be lightened. As it is, we have considerable difficulty in getting engineers to pay enough attention to the proper consideration of this subject, and the tendency is to follow, too frequently, in the paths of by-gone predecessors; whereas, the question of "What Is the Best Protection from Corrosion?" is a vital one, and new facts concerning it come to the front constantly.

Red lead is still being specified as a priming coat by some engineers and architects, for no special reason, that we can find, except that such has been the practice for years, and this in spite of the well-known fact that there is no pigment used by the paint trade that has a stronger affinity for, or is as destructively affected by, sulphurous and carbonic acid gases as red lead. Hence, when used in places where such gases exist, it must be covered quickly by protective coatings, or its durability and value as a foundation coat will be sadly impaired.

We concede, if properly mixed, properly applied and quickly covered by a protective coating, red lead will give a durable first coating; but these ideal conditions do not prevail once in a thousand cases; hence, we claim that you can get better durability by the use of some other material under the prevailing conditions, or by using red lead in ready-mixed form in combination with other selected pigments. For instance, in our No. 700, we combine red lead with graphite, and have splendid records covering the use of this paint under severe conditions.

We want it, therefore, clearly understood that we do not condemn the use of red lead as a paint pigment, as we are large consumers of it, and know its value, but we do affirm that we can get better results by a combination of from 50 to 75 per cent. of red lead with other selected pigments, than by using it pure, and especially where it is mixed by hand as against our machine-mixed paints. We know that graphite is improved by the mixture of red lead with it, and that the mixture of the two is superior to either one used alone.

The author has contended for years that a hand-mixed dry red lead could not be properly mixed and applied by a painter, as an uneven thickness of coating would be given. In some places too much pigment and in other places practically no pigment at all, only the vehicle. The lead companies have now apparently recognized this fact and recommend the use of a paste red lead. It would be very much better if they took one step further and recommended the use of a good grade of ready-mixed suspended red lead paint.

Depending upon the character of the work, climate, location and shade desired for finishing coat, we recommend one of the following paints as a priming or shop coat, in place of a hand-mixed red lead paint, and can guarantee at least equal durability.

No. 31 Williamsport Red Oxide.
250 Blue Lead.
200 Red Lead—60% of the pigment is pure red lead.
300 Red Lead—75% of the pigment is pure red lead.
700 Red Lead and Graphite.
800 Red Lead and Red Oxide.
625 Galvanized Iron Primer.
760 Grillage Black.

The use of iron oxide paint for both shop and field coats on metal is on the increase, and we strongly recommend for this work our No. 31 Williamsport Red Oxide.

The following is from a booklet, "Iron Oxide Paints," published in 1910 by G. B. Heckel, Secretary of The Paint Manufacturers' Association:

When Mother Nature undertakes a piece of work, she completes it. It may take ages, but when done it is done.

All natural red oxides are hematites; the natural brown oxides are usually part hematite and part limonite; the yellow color of all ochres is due to limonite; while umbers and siennas are chiefly limonites with the addition of oxide of manganese. Roasting changes the limonite to hematite, producing respectively red ochres and burnt umbers and siennas.

Vast deposits of these two ores are found in every part of the earth, and these natural colors were the first to catch the fancy of primitive man and were utilized by him for personal decoration or disfigurement long before he learned to use them as ores for the manufacture of iron. Since the dawn of civilization they have been used as pigments and in the twentieth century they still maintain their importance.

Of their general excellence, Hurst says:

"As a pigment, red oxides are perfectly permanent under all conditions and are among the most permanent colors a painter can use. They mix perfectly with all pigments without either affecting them in any way, or being affected by them."

E. Maire says: "Venetian reds made upon a gypsum base are reliable and practically unchangeable by exposure to light and air. Venetian red, either the natural or the artificial, may be mixed with other pigments with perfect safety. * * * It is one of the few colors that cannot be spared and could be replaced by no other red pigment."

Parry & Coste say of the Iron Oxide Pigments: "A most important class of colors, on account of their extensive use * * * and of their high intrinsic value."

Terry says: "The whole group of oxide reds is of foremost importance, by reason of their good color, covering power and durability, besides which, * * * their cost is reasonable."

Bersch says: "The pigments composed of ferric oxide are used in enormous quantity. They are distinguished by great permanence."

Sabin says: "No colors are more permanent than some of these pure oxides. They have lasted for thousands of years and there is no reason why they should ever change."

Zerr & Rubencamp say: "A coating of red oxide paint is a perfect protection against rust, a property upon which is based the extensive use of this pigment for painting ironwork. * * * Oxide red paint is very durable, lasting for many years without suffering any appreciable change."

It is notable that when the famous Paint Test Fences were erected by the Paint Manufacturers' Association at Atlantic City and Pittsburgh, an iron oxide paint was used to protect the entire structures on which the test panels were fastened. The test formulas themselves have given varying degrees of service, but the iron oxide paint is still everywhere in perfect condition and uniformly better than any of the paints tested on the panels.

The National Fire Protective Association, 1908 Edition of Specifications for Fire Doors and Shutters, under painting, recommends:

"Do not paint the doors unless it is necessary, and not until they have first been given a coat of Metallic Brown, Venetian Red, or Red Oxide Paint ground in pure linseed oil."

SNARES AND PITFALLS.

While all that has been said is true of the legitimate oxides and "metallic paints," every good product has its imitators—something "just as good"—for the man that sells it.

There are all grades of oxides made or mined by conscientious manufacturers who depend upon the reputation of their products for future business. Side by side with these there are also all grades of "oxides" manipulated, concocted or quarried for immediate revenue only, and against this class of products the manufacturer, the painter, the engineer, the architect and the consumer cannot be too constantly on guard.

Easily first among undesirable and unfit oxides, especially for use on metal, are those containing soluble sulphates or sulphuric acid. These are always present in oxides made from "pyrite cinder." Such oxides are totally unfit for use, and when applied to metal quickly corrode and pit the surface. Such paints have been known to destroy a tin roof within a few months.

The next defect to be guarded against in iron oxides is insufficient grinding or careless washing or "floating."

Fineness and uniformity of texture have an important influence on the value of these pigments in painting. Robert Job, chemist of the Reading Railroad, found that of two pigments, one high and the other low in iron oxide, the latter far outlasted the former in use, simply because the first was coarse while the other was fine in texture.

We recommend No. 250 Blue Lead for first coating, especially where it will be subjected to extreme exposure from gases in special locations, such as copper smelting works, gas holders, crude petroleum tanks, tank cars and tank steamers.

We recommend the use of our No. 31 Williamsport Red Oxide Paint as a finishing coat over No. 250 Blue Lead.

More carbon paint is sold today than ever before, and its use as a finishing coat over a shop coat of our No. 31, on steel cars, railroad bridges and structural iron work, is rapidly increasing. We strongly advise the use of No. 16 Carbon Black for such work.

White lead and zinc for metal surfaces should only be used when necessary to secure light tints, as more durable results can be obtained by using oxides or carbon pigments.

Graphite has not proven to be as desirable a pigment for durability as was expected, and its use, by itself, as a paint pigment is on the decline. It gives best results when used in combination with other selected pigments, such as, for instance, our No. 700 Red Lead and Graphite.

Our No. 32 Natural Color Graphite is usually made from the Mexican graphite pigment, as our tests have proven that for most locations, this pigment gives the best results. We, however, carry regularly in stock, in addition to the Mexican air-floated graphite, the Acheson artificial graphite pigment, and are prepared to give to our customers their choice of Acheson or any other graphite pigment that can be purchased. This artificial graphite is made principally from anthracite coal, treated in electric furnaces, at a very high degree of heat, and air-floated.

The main trouble with some of the graphite paints on the market is caused by the use of a graphite pigment which does not combine readily with the oil and when spread on thin, even repels it, so as to cause many minute holes, which retain the moisture and cause corrosion.

Henry A. Gardner, Director of the Scientific Section, Paint Manufacturers' Association of the United States, states in Bulletin No. 29, page 34, as follows:

"Graphite, both in the natural and artificial form, contains impurities such as silica, iron oxide and aluminum, in some cases as high as 40 per cent. Graphite is easily mixed with other pigments, such as red lead and blue lead, thus making a better paint coating. Its use as a prime coating for steel should be avoided, as it tends to stimulate corrosion."

Magnetic Black Oxide is a new pigment consisting of about 91% of Fe_3O_4, which has come into quite extensive use during the past five years. Our tests show it is of considerable merit when used in combination with other selected pigments.

In 1908 tests were commenced at Atlantic City, N. J., under the direction of the American Society for Testing Materials and the Paint Manufacturers' Association, to determine the value of various pigments for the painting of steel. The final report of these tests in 1914 gives the rating of the leading pigments as follows, 10 being considered as perfect:

Basic Lead Chromate	7.5
Sublimed Blue Lead	6.0
Red Oxide, with Barytes, etc.	5.0
Carbon Black with Barytes	5.0
Willow Charcoal	4.5
Magnetic Black Oxide	4.0
Red Lead	4.0

The Basic Lead Chromate paint costs nearly four times as much as the Blue Lead paint, and five times as much as the Carbon Black or Magnetic Black Oxide. Its greater cost forbids its use in most cases.

The use of Lithopone as a paint pigment in interior paints is increasing rapidly, and it would seem as if it would entirely displace white lead for interior work. Lithopone is made from zinc and barytes chemically combined. It is non-poisonous and does not discolor in dark places as lead does. It has not been made as yet so as to be durable for exterior paints.

VEHICLES.

There is quite a difference of opinion as to whether to the oil or the pigment is due the life of the paint. In our opinion to neither one can be given the entire credit, but the life or durability of the paint is due to a proper combination of the two. No amount of theoretical knowledge can determine questions of this kind, but it takes the practical experience of years in the actual manufacturing of goods, and also the proper use of them, to obtain the best results.

For exterior paints the oil vehicle should be a selected, well aged, linseed oil, and in most cases greater durability is obtained by using raw linseed oil in preference to boiled.

In making protective paint for metals too little attention is given by some to securing the proper vehicle in which to grind the pigment, and also as to the best drier to use. While it is true that the use of the proper pigment helps to protect the oil from decay, it is also true that a chain is only just as strong as its weakest link; so a paint is only just as permanent as the constituent which suffers decomposition and decay permits it to be. There is not in use at the present time a paint vehicle that will permit of a permanent protective painting compound being produced. Linseed oil is not the ideal vehicle, but nothing better as yet has been discovered for universal painting requirements, but for some locations other oils, such as Chinese wood oil, soya bean oil and treated fish oils can be used to advantage.

A great deal depends on the drier used, different pigments require different driers; many paint manufacturers only use two—turpentine drier and a benzine drier. Our long experience has taught us the need of many different kinds of driers for different paints; hence, we carry a larger assortment of driers than other paint manufacturers.

LINSEED OIL VERSUS PAINT AS PRIMING COATS FOR METAL.

The following is taken from a paper by Frank P. Cheesman read before the American Society for Testing Materials at its Annual Meeting, 1907:

Previous to 1885 it was almost a universal custom to use boiled linseed oil as a shop or priming coat for metal; this was largely due to the fact that but little attention was given in those days to the subject of corrosion, while today we have almost gone to the other extreme, and corrosion has become a favorite topic at our meetings, and the theories presented differ so much that the layman is apt to grow confused, and throw up his hands in despair; and yet the agitation has resulted in great improvement and progress in preventing corrosion, notwithstanding the destructive forces that we have to contend with increase in number yearly, and the metal that we have to protect in many cases is no longer passive, but also frequently produces a destructive attack from the rear upon the protective coatings applied to the surface.

At the present time very few bridge engineers specify the use of boiled oil, and yet there are enough still doing so to make it worth the effort to call their attention to the fact that they are making a mistake and inviting corrosion by so specifying.

At a meeting in 1906 of our New York section of the Society of Chemical Industry, Dr. Sabin, in an article on "The Oxidation of Linseed Oil," showed that, after the same oil had been placed in six glass flasks, connected together with tubing, and allowed to stand in a well lighted room, there was such a difference in the weight after drying that one had gained two and one-half times as much as the other, the figures being 10.1 and 25.5 per cent.

Dr. P. C. McIlhiney, at the same meeting, said with regard to the atmospheric oxidation of linseed oil, he had himself found that the same sample of linseed oil would at different times and under conditions that were apparently the same, absorb very different percentages of oxygen, or at least that the increase of weight on drying was very different.

I mention the above to show why it is possible to have conflicting results when the paint maker has made no change in his vehicle; linseed oil is today the best paint vehicle we know of, but it contains some of the still unknown mysteries of nature, and it occasionally gives us a knockout blow.

While a few still contend that linseed oil, when dry, is not porous, the majority believe (and especially as applied to boiled linseed oil) that it is hygroscopic in its nature; the proof of the pudding cannot in this case be found in the eating, but it can be found in the following field tests:

Several very interesting facts were stated by practical men at the third annual convention of the Maintenance of Way Master Painters Association of the United States and Canada, held in New York, November 13 and 14, 1906, and are printed in their proceedings, and I will mention the following, copied from those proceedings:

Edward Hurst Brown, in his paper on "Conditions That Must Be Met in the Ideal Paint for Railway Bridges," stated as follows:

"The most insidious enemy of the iron bridge is rust, and the primary object of painting it is to protect it from those elements which cause destruction by rust. Rust is caused by the combination of the metal with oxygen to form the hydrated oxide of iron. This oxygen may be obtained from the air, from water, or from some other substance which acts as a carrier of oxygen or an oxidizing agent—always, however, in the presence of moisture. Now, one of the primary things to be considered in choosing a paint for iron work is that it shall not contain in its pigment or vehicle any substance which is chemically active in such a way as to convey oxygen to the iron. For if such a chemically active agent be introduced into the paint, sooner or later it will promote rather than prevent rust. Of course, so long as the oil, in an oil paint, remains intact, it envelops the particles of pigment and keeps them away from the iron, but in time the oil, which has hardened by absorbing oxygen from the air, begins to disintegrate by the action of water coming from rain, hail, snow or fog. Moreover, even the freshly applied oil is not absolutely impenetrable to moisture, as has been shown by numerous experiments, and, however completely the particles of the chemically active pigment may be covered by an oil film, they will necessarily come in contact with moisture—will decompose the water and absorb its oxygen, and convey it, together with the hydrogen, to the surface of the iron to cause rust. For this reason the ideal paint for a steel or iron bridge should not contain a chemically active pigment, nor any strongly oxidizing agent in the way of driers."

"We have also seen that linseed oil is permeable to moisture and to the gases and steam from locomotives. This was first clearly demonstrated, we believe, by Dr. C. B. Dudley, chief chemist of the Pennsylvania Railroad, and to this fact may be ascribed the corrosion of the metal under an apparently intact coating of paint. It is true that in the mixture of oil with pigment in a very finely divided form, the tendency is for the pigment particles to more or less fill up the interstices in the oil film and render it less porous."

The author of this Review, in the course of his remarks, made the following statements:

"Any practical master painter will allow that boiled linseed oil, when used alone for the first coat on metal, will not dry hard in weeks. It oxidizes on the surface, absorbing moisture and forming a skin, leaving the underneath portion soft, and easily knocked off in shipping, and later on will cause subsequent coats of paint to crack and peel. This is because the first coat of oil must dry some time, and in doing so will force the top coats to crack, and sooner or later come off.

"Mr. Emil Gerber, M. Amer. Soc. C. E., in his report on the Illinois Central Railroad bridge at Cairo, Ill., shows that the approaches which received one shop coat of paint weathered better than the bridge which received one shop coat of oil. When the Cumberland Valley Railroad bridge was built in 1887 at Harrisburg, Pa., it was built jointly by the Edgemore and Union Bridge Works, and one applied a shop coat of paint and the other a shop coat of oil. After erection it was found that the oiled part of it was rusting very badly. Two coats of our paint were soon applied on the entire structure, and the section that received one coat of paint at the shop stood much the better."

We also quote M. P. Wood ("Rustless Coatings," page 25):

"There are hundreds of records of the painting of important railway structures, where the first coat of boiled oil method was used and, in the great majority of instances the utter and rapid failure of the coating and the extra corrosion of the structure could be directly assigned to this so-called method of protection. The weather-resisting power of an oil coating is almost *nil* as compared with paint."

"A foundation coat of oil is a direct cause of the blistering and peeling of the coatings spread over it. It is seldom dried enough before the other paints are spread over it to ensure a close adherence to the metal it covers. When the subsequent coats of paint are spread, the solvents and oils in them soften to some extent the underlying coat of oil, and a moderate heat from the sun causes the whole coating to blister or peel. Too much oil in a paint coating, particularly if the surplus oil is in or near the foundation coat, whether on a wooden or metallic surface, will generally cause peeling regardless of the pigment used in the coatings."

We also quote G. W. Thompson, Chief Chemist, National Lead Company, who are large crushers of linseed oil:

"We have condemned the use of linseed oil as a prime coat for iron and steel for the reason that it is impossible to tell whether the application has been well made or not. But more important than this, a linseed oil priming coat should be condemned for the reason that all under coats of paint should be as hard as possible, which is not obtained when a linseed oil priming coat is used. Whatever rust-preventing power subsequent paints may have tends to be nullified by being separated from the iron and steel by a linseed oil film. A hard protective coating gives the best possible foundation for a subsequent paint."

The question now arises: What pigment would you recommend using in connection with linseed oil for a priming coat, and to this I answer that the paint doctor must be advised upon several points before he can prescribe the proper pigment.

Will the metal be painted under cover, and how much time will be allowed for drying? If it is a rush job, we want to use a pigment that will not retard the drying of the oil. What are the climatic conditions? Is the material to be shipped a long distance, and what kind of exposure will it have before it is second coated? Will the metal be properly cleaned before the shop coat is applied? All of these questions must be answered before we can state intelligently what is the best pigment to use, but where no information can be obtained, as a general rule, it is safe to use a selected high-grade natural ore iron oxide like our No. 31 Red Oxide.

REINFORCED CONCRETE AND CEMENT COATING.

There have been published in several trade papers, articles advocating the use of a thin coating of cement on iron or steel to prevent corrosion. A thin coat, even if it could be applied successfully and remain on without cracking (two impossibilities), would not prevent corrosion for a very long period for the following reason:

The cement for a while would take up the oxygen, thus allowing only pure water to reach the iron, and pure water will not cause rust, but after a while the cement reaches its limit as regards the taking up of the oxygen, and from then on ceases to be a protector of the iron. The trouble with this cement experiment, as with many others, is that it was not given a sufficiently long-time test.

If the concrete is several feet thick, free from cracks, and not exposed to running water, it will better protect iron or steel from corrosion, especially where it is below the water line and gets constant immersion, but all structural steel that is to be imbedded in concrete should be protected with paint.

We were one of the first paint manufacturers to recognize the necessity of using a paint containing no linseed oil, as a final coat on structural steel, when that material was to be incased in concrete. It is a well-known fact that the lime contained in concrete will quickly destroy linseed oil, which leaves the coating of paint without a binder, so that it soon becomes little more than a powder with no value as a protective coating.

Having this in mind, we have placed upon the market our No. 755 "SUBWAY BLACK," which contains, instead of linseed oil, especially prepared vehicles and pigments, which are not affected in any way when placed under or over concrete.

It is a fact, however, that paint which is to be used as a priming coat and is applied to the bare metal, should be made of linseed oil, and for this class of work we recommend our No. 31 Williamsport Red

Oxide of Iron Paint, the oldest and best known structural and bridge paint on the market. Over this paint should be used one or two coats of "SUBWAY BLACK," and this combination will come as close to giving perfect protection to structural steel when incased in concrete as anything that has yet been produced.

No. 755 "SUBWAY BLACK" has good covering capacity (about 400 square feet per gallon, one coat), and it will not become hard in the barrel during cold weather, which condition is frequently experienced with similar paints of other makes.

In a paper read before the American Institute of Electrical Engineers at New York, March 1, 1907, the following conclusions were presented as the result of research that has been carried on for several years to ascertain whether concrete will afford protection to iron and steel against electrolytic corrosion:

1. Steel structures are well preserved from ordinary corrosion by concrete if placed either in salt or fresh water. This, however, has long been known.

2. If but a small fraction of an ampere of electricity passes from an interior metallic column or structure into concrete or masonry as usually made, there will be corrosion of the metal and disintegration of the concrete or masonry.

3. Structures of steel in concrete that are subject to sea water are in more danger from electrolytic action than those in fresh water, by reason of the lower resistance of concrete in sea water, as shown by the laboratory experiments.

4. In no sense can concrete be considered an insulator, and it is from all appearances just as good an electrolytic as any of the soils found in the earth.

In a paper read at the ninth general meeting of the American Electro-Chemical Society, the following statements were made:

"Seven steel strips were placed in neat cement and subjected to an electric current. At the end of the third day corrosion had commenced, except on that portion of the steel strips which were painted with an insulating paint of known composition, and the experiment was continued for a number of days, after which the briquettes were broken open, and it was demonstrated that electrolytic corrosion had taken place most effectually, except on that portion of the steel that was coated with the insulating paint, and the impression that cement is a protection against corrosion at all times is fallacious, and an increase in volume may take place which will split the concrete shell."

Dr W. H. Walker, in a paper read before the New York section of the American Chemical Society on May 10, 1907, stated that carbon dioxide is not necessary in order to produce corrosion, while it does accelerate the corrosion. Oxygen alone will produce corrosion without any carbon dioxide in connection with it.

The rust-forming agency is a solution of oxygen in water. This constitutes the whole secret of the production of rust. Hence, it follows that other conditions being equal, cold water is more active in producing rust than hot, and iron rusts much more rapidly when the contact with water is intermittent than in cases of permanent immersion.

The oxide from electrolysis is always .75 oxide—the magnetic oxide (Fe_3O_4)—and leaves a black mark or streak. The oxide due to rust, cinders, etc., is always .66 oxide (Fe_2O_3) and leaves a red streak. The .75 rust never occurs in the street except through electrolysis.

The oil-destroying properties of the alkali in cement have caused trouble in painting concrete, which can be overcome by a method described by Charles Macnichol in a paper presented to the American Society for Testing Materials, in 1910.

The method consists in treating the cement surfaces with a solution of equal parts by weight, zinc sulphate and water, applied with an ordinary bristle brush, after the cement is dry. If the precaution is observed of allowing 48 to 72 hours as a drying period, this treatment will render a cement wall as safe to paint on as an ordinary plaster wall. At Mr. Macnichol's request, Dr. A. S. Cushman prepared the following explanation of the chemical reasons for the success of zinc sulphate in such work:

"In regard to the scheme for painting concrete work with a solution of zinc sulphate in order to make the surface hold a paint coating, it is my belief that the zinc sulphate is very well adapted for this purpose owing to the fact that when zinc sulphate is brought into contact with the calcium hydroxide (hydrated lime) a chemical reaction results in the formation of calcium sulphate (gypsum) and zinc hydroxide (hydrated oxide of zinc). It is apparent from this that after the surface has become thoroughly dry again it will contain within its pores a mixture of gypsum and zinc oxide. These materials have no bad influence on linseed oil and, in fact, are frequently used as paint pigments."

GREENBRIER HOTEL, WHITE SULPHUR SPRINGS, W. VA.

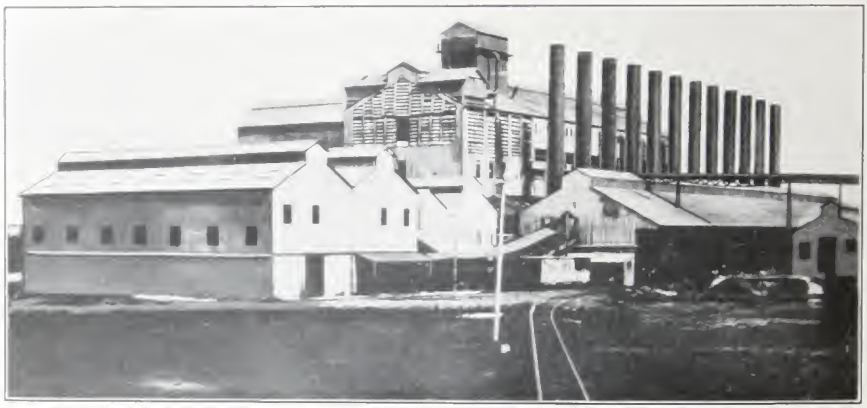
Thos. J. Bird, Steel Engineer. Erected 1913. This hotel is fireproof throughout and the steel is entirely encased in concrete. In the shop, the steel received a coat of our No. 17 Brown Oxide, and after erection it was painted with No. 755 Subway Black Paint. This latter paint (which contains no linseed oil) is not affected by the concrete, and insures absolute and permanent protection to the structural steel. For this class of work, we recommend a shop coat of No. 17 Brown, or our No. 31 Williamsport Red Oxide, and No. 755 Subway Black Paint for the final coat. For interior surfaces specify NaPaWork Interior Flat Finishes, and either our Sun-Wite, Lustre-Wite or Keap-Wite Enamels.

PAINTING STEEL BRIDGES.

The question of durability regarding the painting of steel bridges is not so much a question of season as it is a question of favorable weather. So far as temperature is concerned either extreme (hot or cold) is equally detrimental to paint. Extreme heat forces paint to dry rapidly and therefore unnaturally, while extreme cold retards the drying and consequently also causes unnatural drying. Oil paint wastes much in weight and body under extreme heat, while the reverse is true in cold weather. The latter is an advantage, but is offset in many instances by the injury sustained wherever the paint becomes frosted before it is dry. When an oil paint dries naturally, it absorbs the requisite amount of oxygen, but if forced by extreme heat or by the addition of artificial driers, its durability is correspondingly impaired. A temperature of from sixty to seventy degrees, provided the atmosphere is not overladen with moisture, is far more conducive to durability than either extreme heat or cold. Water, which is usually to be found in considerable quantity near or underneath most steel bridges, is a factor to be reckoned with, in bridge painting. The ascending moisture caused by the evaporation of the water is very detrimental, especially while painting, unless there is sufficient heat to dissipate it before it envelops the steel structure. On this account much care is necessary in order to guard against painting over and sealing up in the pores of the iron, such moisture that may have been absorbed by the metal. Moisture thus absorbed will remain indefinitely, so long as there has been a protracted season of dry weather of sufficient duration to dry it out. That portion of a bridge most exposed to the rays of the sun presents the greater advantage for painting in winter on account of the action of the sun in freeing the metal of moisture. It is a good plan and not impracticable in bridge painting to be governed by the position of the sun, or more correctly speaking, by the position of such structures to the sun at various seasons. As, for instance, painting the sunny side of a bridge in winter when conditions permit it, and those parts never reached by the sun in warmer or drier weather. Another feature of bridge painting, whether in winter or summer, that does not always receive the attention it should, is the method of cleaning and application of paint. When it becomes necessary to scrape away or sandblast the structure, thus exposing the bare surface of the metal, the cleaned surface should in no instance be left unprotected over night, or for a period sufficiently long to absorb moisture, but should be followed up immediately with the painting. Sand-blasting a bridge or other structure previous to painting has the advantage of being dried of itself, all moisture at the same time to a large extent by the compressed air that operates the sand-blast, that is, provided the atmosphere is not overcharged with moisture, as the air taken in by the compressor is necessarily of the same humidity as that of the surrounding air.

NEW YORK MUNICIPAL PIER.

1,400 feet long, 270 feet wide, cost $1,000,000. Foot 33rd Street, South Brooklyn, New York. 2,500 tons, steel. Erected by the Snare & Triest Company, in 1911-1912. Finished with Technical Paints manufactured by CHEESMAN & ELLIOT. We have recently furnished the paints used on N. Y. N. H. & H. R. R. Piers 39, 40 and 42, E. R., New York City. The new ferry house at 39th Street, South Brooklyn, is finished with our paints. Our No. 625 Galvanized Iron Primer is used extensively on the galvanized iron pier sheds in New York City. The Municipal Pier shed at 131st Street, N. R., was finished with our paints, including No. 625, during January, 1911, and on January 1st, 1915, the paint was still in first-class condition. Our paints were also used on the Clyde Line Pier. The galvanized iron shed of D. L. & W. R. R. Pier No. 26, E. R., was given a priming coat of No. 625 Galvanized Iron Primer.



STEWART SUGAR MILLS, CUBA, W. I.

PAINTS FOR TROPICAL CLIMATES.

For over thirty years we have made a specialty of "Technical Paints" for export, especially prepared for the trying climatic conditions found in tropical countries.

The majority of the sugar mills, bridges, docks, warehouses, stations, etc., in Cuba and Porto Rico, for instance, are protected with our paints. Among our customers, we mention: Stewart Sugar Co., Central Saratoga, Central Aguirre, Central Fajardo, Central Ciego de Avila, Senado Sugar Co., United Fruit Co., Havana Central R. R., United Railways of Havana, Cuban Central, Guayaquil & Quito R. R., Tehauntepec R. R., National Railways of Mexico, Cuba Co., etc.

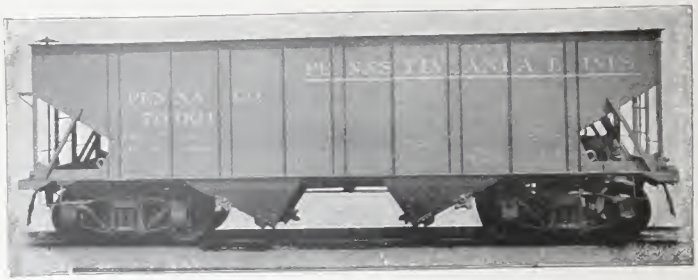
The leading paints we ship for export are No. 31 Red Oxide, No. 16 Carbon Black, Suspended Red Leads, No. 625 Galvanized Iron Primer, No. 759 Smoke Stack Black, No. 32 Graphite, No. 94 Gray, No. 1031 Smoke Stack Red, No. 21 Prince's Metallic Brown, No. 250 Blue Lead, No. 57 Flat White, etc.

HELL GATE BRIDGE.

Cheesman & Elliot have contracted with the American Bridge Company to furnish during 1915 the final field coat of paint for the steel work of Hell Gate Bridge, on the New York Connecting Railway.

This work will require about 15,000 gallons of paint.

This bridge provides a direct connection between the New Haven and Pennsylvania R. R. Systems. It crosses the East River at Hell Gate, and is the longest arch bridge span in the world. The clearance above high water is 135 feet. The span is 977 feet 6 inches. The towers are 125 feet by 140 feet in area; hollow concrete construction, faced with Mame Granite, and are about 220 feet high. The span will have a total weight of 26,000 tons.



STEEL FREIGHT CAR PAINT.

The following remarks are taken from a paper written by the author of this Review, which was published by the Central Railway Club in their Official Proceedings, November, 1914:

"In 1910 it was my privilege to read a paper on the subject of 'Protection of Metal Equipment,' before the New York Railroad Club, and some of the remarks that I will make now will be to some extent a duplication of what I said then.

"While some progress has been made in the method of painting since 1910, the basic facts are about the same as they were then. The subject should be divided into two headings; first, as applied to new cars constructed by car builders not connected directly with the railroad, and second, as applied to the re-painting of steel freight cars by railroads.

"Under the first head it is almost impossible, with the conditions as we find them at the car-builders' shops, to secure sufficient time for painting the car properly. In many of the shops it is the practice to put on two coats of paint in one day; frequently the stenciling of the car is done that same day or the following day. No shop that I am familiar with has sufficient space to carry on its tracks more than one or two days' output when working full time. It is, therefore, absolutely necessary that the cars be moved rapidly. Under such conditions it would be throwing money away to attempt to do a first-class job or to use high-grade materials. I would, therefore, suggest that in specifying paint for new steel cars, when not more than twelve to twenty-fours can be allowed for painting, that only a single coat of paint be specified for the work, and that to consist of an iron oxide paint containing between 30 to 40 per cent. sesqui-oxide. The vehicle to consist of pure raw linseed oil, a percentage of Kauri Gum china wood oil mixing varnish with sufficient drier to dry it in the requisite time, making that time as long as possible under the conditions.

"The car painted under the above conditions should be shopped in from six to eight months by the railroad and then given a thorough job of painting as described hereafter. If the railroad is not going to re-paint the car within six or eight months, a second coat should then be applied at the car shops, rather than to allow the car to run longer than eight months with only one coat of paint on it. And in that case if a black finishing coat is desired the second coat of paint should contain only sufficient carbon black to make the shade required. The majority of the pigment being iron oxide in combination with magnetic black oxide and inerts.

"There is no question but what more paint is ruined by poor application than in any other way. The men who paint freight cars in car-builders' shops usually are not skilled painters, and it is necessary under present conditions to apply the paint under various degrees of temperature. It is frequently rained or snowed upon before becoming dry. In many cases the thinning is done with cheap and worthless oils and japans and the only wonder is that it stands as well as it does under the poor application and thinning.

"There is a vast difference in the character of metal almost as much as there is in the character of wood, and this has a great effect on the durability of the paint. If the priming coat could be applied while the metal is warm we could obtain much better results than are now secured.

"The designing engineers are apt to overlook the fact that the painting of a steel car is an important factor in the maintenance of it. Frequently a small change in the plans will materially assist the proper cleaning and painting of the car. We often see angles specified where a rounded section could be used just as well, thereby giving the protective coating a better chance, because it is on the edges where it wears off first. On a round bar there is about one-eighth less surface to cover as compared with a square bar of the same sectional area. Quite a little improvement has been made along this line, but much more could be made, especially in the case of pockets, which should be avoided in every possible case.

"One of the principal sources of corrosion is the rivet heads and the rivet holes. You cannot protect these holes with paint when red hot rivets are used, and I suggested in 1910 that it would pay to even plate these holes with a non-corrosive metal and also use non-corrosive rivets, especially as applied to passenger coaches. At that time there was no method on the market of coating metal which could be utilized for this class of work, but there has been lately introduced a metal spraying apparatus which, I am told, will do this class of work successfully, and a coating of lead, zinc or brass can be applied at a comparatively low cost. A description of this new process of metal coating can be found in *Engineering News*, Vol. 72, No. 18, of October 29th, 1914. I think that the matter would pay the members of this Club to investigate.

"All over-lapping joints which cannot be reached to be re-painted should be coated with a heavy coat of pure blue lead made in semi paste form.

"Under the second heading, 'The Repainting of Steel Freight Cars by Railroads,' after the surface is put in proper condition by sand-blasting off all of the original coating, including the rust and mill scale, I then recommend applying a coat of paint made with a high-grade natural ore iron oxide containing about 75 per cent. of sesqui-oxide reduced to about 40 per cent. of sesqui-oxide with silica and other selected inert pigments non-hygroscopic in their nature. The vehicle to consist of pure raw linseed oil with a selected drier and a percentage of a hard gum china wood oil mixing varnish. Better results could be obtained by the railroad if this paint was bought ready-mixed with the exception of the drier, which should be added to the paint at the time of painting. The amount of drier to be governed by the weather and the time allowed for painting.

"For a finishing coat I recommend the use of a carbon black paint containing magnetic black oxide in addition to carbon black, and a percentage of selected inert pigments with practically the same vehicles as used in the priming coat.

"I would suggest that special attention be given to the quality and size of the paint brush, and that a larger brush than a 6-0 Round Brush or a 6-inch Flat Brush should not be used, and that the preference be given to the round brush, as the workmen cannot brush the paint in and on as well with a flat brush as with a round brush. I do not believe that a paint spraying machine can be used that will give as durable results as you can secure by using brushes in the hands of good painters.

"I believe that when a railroad finds that a paint-maker is repeatedly guilty of not living up to the paint specifications such people should not be allowed to bid on their paint requirements. Unless the railroads do formulate a plan to eliminate unreliable bidders, it will be hard to induce reputable manufacturers to bid on their paint specification requirements."

BAY RIDGE HIGH SCHOOL, BROOKLYN, NEW YORK CITY.

Structural steel painted with our No. 31 English Red Oxide. Cheesman & Elliot's structural paints are regularly approved by the Board of Education of New York City for use on the structural steel of school buildings. Their standard specifications also call for Cheesman & Elliot's No. 625 Galvanized Iron Primer on galvanized iron heating and ventilation systems, and Cheesman & Elliot's Radiator Enamel. Our NaPaWork Flat Finishes, made in all colors, are used largely for ceilings, side walls, etc.

HOW TO ESTIMATE THE QUANTITY OF PAINT REQUIRED.

To find the amount required to paint the structural iron of a bridge or building, take the estimated weight, for instance, of the framework of a building of 450,000 pounds of an average thickness of 5-16 inch. A square foot of 5-16 inch iron weighs 12.75 pounds; divide the total weight, 450,000, by 12.75 equals 35,300 square feet one side. As both sides are to be painted, double this, making 70,600, and add 5 per cent. to cover top and bottom; equals about 74,000 square feet. The covering capacity of each paint will be found under the description of the paint

POWER PLANTS.

The quality of paint used by power companies must be of the best, as with them the painting question is a matter which is given considerable attention. It is not always possible to paint water wheels, pen-stocks, under-water pipes, etc., as temperature changes and other conditions have to be considered. It is, therefore, evident that only a technically made paint, manufactured for some particular surface, can be satisfactorily used by a power company. This is one reason why we are, at the present time, supplying some of the largest power companies in the country with all of the paint which they use. These include the Niagara Falls Power Co., Toronto Power Co., Canadian Niagara Falls Power Co., Amherst Power Co., Ontario Power Co. of Niagara Falls, and others.

About ten years ago the Niagara Falls Power Co. conducted a series of paint tests. In these tests our specially made paints stood up to such good advantage that the Niagara Falls Power Co. has been using our paints on all of their work ever since.

Pen-stocks and water wheels which are wet or sweating practically all of the time, require the protection of a paint which is especially prepared to meet these conditions, and our No. 700 Red Lead and Graphite has proven to be the best paint which can be used for this class of work. On new pen-stocks or water wheels, the priming coat should be our No. 300 Suspended Red Lead, to be followed by two finishing coats of No. 700 Red Lead and Graphite.

For under-water pipes, our No. 500 Black Metal Protector will give the best service.

On transmission line poles, towers, etc., nothing better can be used than our structural iron paints, namely, No. 31 Williamsport Red Oxide for the first coat, No. 401 Carbon and Oxide for the second coat, and a finishing coat of No. 16 Carbon Black.

We are also large manufacturers of Concrete Floor Paints, and for interior walls, ceilings, etc., our NaPaWork Flat Finishes, particularly No. 57 Flat White, make very satisfactory and durable coatings.

To insure the best results on smoke stacks, a paint containing special vehicles must be used, and for this purpose we recommend No. 750 Smoke Stack Black. As the name implies, this is a jet black, glossy paint, and on stacks, generator pipes and other hot surfaces it will wear longer and look better than any other paint known. No. 750 Smoke Stack Black will give good service on any metal surface that is not subjected to over 400 degrees Fahrenheit.

We are often called upon to make up a paint for some particular use about a power plant and are always glad to give such matters our special attention.

SUMMING UP.

A review of the previous articles, tests and experiments suggests the following conclusions:

First. That the chemist is not usually a paint expert. His mission is to analyze and hunt for adulterants and find if specified materials are used.

Second. That the laboratory test is not practical or conclusive, as it is generally much more severe than are natural conditions.

Third. That long-time weather tests are conclusive, for they meet conditions that are encountered in actual practice.

Fourth. That the red and brown oxides of iron when properly selected and roasted are the best pigments for all around weather exposure; but these pigments are often abused by being adulterated with cheap, worthless oils, which have brought them into bad repute, and many common mineral or iron ore pigments, which are of no value as paint pigments, are mined and ground and used just as they come from the earth. Pigments obtain their value, color and durability from the *fire* treatment they receive in making them inert and unchangeable.

Fifth. Carbon comes next to the oxides, and under some conditions of exposure is even superior.

Sixth. Graphite has not proven to be as desirable a pigment for durability as was expected, and gives best results when used in combination with other selected pigments, and should never be used for priming coats.

Seventh. For first coating in many locations we are convinced that a first quality red or brown oxide of iron is as durable as red lead, and for some purposes superior, because it is impervious to the action of sulphureted hydrogen and all other deleterious gases, and keeps in better suspension.

Eighth. As a general paint vehicle nothing yet has been discovered to equal pure raw linseed oil.

Ninth. It requires thought, labor and experience along special lines to produce satisfactory paints, and that even with a high-grade product quantity and proper application are as essential as quality.

Tenth. Another feature essential to the production of a good paint is that the pigment should be finely ground, both in its dry state as well as with the vehicle. When this is effected every minute particle of pigment will be thoroughly impregnated with oil or varnish, and the whole will form a perfectly homogeneous mass in which no granules will be found. If, however, the pigment, though in ever so fine a state of division, be merely stirred into the vehicle, without grinding, it will remain granular or gritty, and these irregularly impregnated particles of pigment are able to absorb moisture and facilitate its admission to the surface of the metal.

Eleventh. And last but not least, more paint is ruined by application to a surface not suitably prepared to receive it than by any other cause.

NORFOLK & WESTERN R. R. COALING PIER NO. 4.
NORFOLK, VA.

Completed January, 1914. Fabricated and erected by the Virginia Bridge & Iron Co. 8,000 tons of steel. Finished with two coats of Cheesman & Elliot's No. 16 Carbon Black; 4,000 gallons being used. Pier is 1,200 feet long and 90 feet high. Capacity, 5,400 tons of coal per hour

No. 16.

CARBON BLACK.

This paint is one of our oldest and best known coatings. It is composed of high-grade pure carbon black with magnetic black oxide and a percentage of inert pigments, combined with pure linseed oil and our special driers and binders. We have manufactured it since 1876, with improvements from time to time, and it has been used on more structural steel bridges, and other metal structures than all other black paint combined on the market.

No. 16 dries jet black, with a bright lustre; works smoothly and easily under the brush, and has excellent body—a feature often found lacking in paints made with carbon and graphite pigments.

Carbon Black is, without doubt, one of the best pigments for a protective coating. It is the best light excluder, and is practically exempt from destruction by atmospheric influences. Being very fine in texture, it is an excellent protector of the vehicle of the paint, and at the same time produces an elastic coating, thus reducing the fractional element due

to beating of storms, and expansion and contraction of metal. It remains in place until removed by friction or the destruction of the vehicle, and can be painted over without the expensive scraping or torch-burning necessary with some other pigments.

Many instances are on record where a single coat of carbon black like that used for lettering and symbols on the old cross-roads and tavern sign-boards that have been exposed for a century or more, is still uninjured, while the surrounding colors and, in many cases, the wooden surface of the sign, have been worn away, leaving the carbon lettering in full relief.

Below are mentioned some of the railroads which have specified or purchased No. 16 for their bridges during the past ten years. A number of these roads have adopted No. 16 as their standard bridge paint, while the others have used it on many of their largest structures.

Atlanta & West Point
Auburn & Syracuse Elec.
Baltimore & Annapolis Short Line
Bessemer & Lake Erie
Boston & Albany
Buffalo, Lockport & Rochester
Buffalo, Rochester & Pittsburgh
Buffalo & Susquehanna
Carolina, Clinchfield & Ohio
Central of Georgia
Chicago & Alton
Chicago, Indiana & Southern
Chicago, Milwaukee & St. Paul
Chicago, Milwaukee & Puget Sound
Chicago, New Orleans & Texas Pacific.
Cleveland, Cin., Chicago & St. L.
Coal & Coke R. R.
Cuba R. R.
Cumberland Valley
Davenport, Rock Island & Northwestern
Empire United Rys.
Guayaquil & Quito
Lake Shore & Michigan Southern
Minneapolis, St. Paul & S. S. M.
New York Central
New York, New Haven & Hartford
Norfolk Southern
Norfolk & Western
Northern Central
Northern Pacific
Pennsylvania Lines, East
Pennsylvania Lines, West
Peoria & Pekin Union
Philadelphia, Baltimore & Washington
Pittsburgh & Lake Erie
Seaboard Air Line
Southern
Spokane & Inland Empire
Spokane, Portland & Seattle
Susquehanna, Bloomsburg & Berwick
Syracuse, Lake Shore & Northern
Union Traction Co. of Indiana
United Fruit Co.'s Lines
United Rys. of Cuba
Vandalia Lines
Virginia-Carolina Ry.
Virginian Ry.
Virginian & Southwestern
Winston-Salem Southbound

It has been abundantly demonstrated that No. 16 Carbon Black is the most satisfactory bridge coating on the market, especially as a finishing coat over a first-class priming coat such as our No. 31 Red Oxide. It has a record of over 25 years as the Standard Bridge Paint of the Norfolk & Western Ry. Four thousand gallons of No. 16 were used on the large coaling pier of this road, erected at Norfolk, Va., in 1916, and over four thousand gallons were used on their new ten thousand ton bridge over the Ohio River at Kenova, W. Va.

Several of the divisions of the Pennsylvania Lines both East and West of Pittsburgh have used No. 16 continuously for over 35 years in connection with No. 31 as a priming coat, and in some of the shops of this road, Nos. 16 and 31 are regularly carried in stock.

The Carolina, Clinchfield & Ohio used over 7,000 gallons of Nos. 16 and 101 Carbon Paints (in addition to our No. 100 Carbon Black used by the bridge companies for the same work) in 1907-1909, and only started to repaint some of the bridges with the same paints in 1913-1914.

The Boston & Albany R. R. recently specified No. 16 for several bridges, together with our No. 31 Red Oxide and No. 300 Suspended Red Lead as shop coats. They also used these paints on their new piers in Boston.

The Chesapeake & Ohio Ry. purchased several thousand gallons of No. 16 for use on bridges during 1913-1914. It has been the standard bridge paint of the Buffalo, Rochester & Pittsburgh since 1908.

No. 16 over No. 31 withstands tropical conditions better than any other paint.

All bridges of the Union Traction Co. of Indiana are painted with No. 16. It is used by other large interurban systems, among which the Buffalo, Lockport & Rochester Ry., and Empire United Rys. have used large quantities for bridges.

Several great trunk lines of the West have used No. 16 extensively. Among these are the Chicago Great Western; C. M. & St. P.; C. I. & S.; C. C. C. & St. L.; D. R. I. & N. W., and many others.

Many county and city bridges are coated with No. 16, and we mention among these the city bridges in Roanoke, Va.; Binghamton, N. Y., and Springfield, Mass. A number of bridges of Passaic County, N. J., were painted in 1914 with No. 16 over a priming coat of No. 31.

No. 16 has been used as a protective coating for the structural steel of some of the largest buildings in the country. The Pennsylvania Steel Co. and Bethlehem Steel Co. have used large quantities on their own buildings, as well as on structures for their customers, and the American Bridge Company and other large steel erectors purchase thousands of gallons of it every year.

The average covering capacity of No. 16 on metal is about 850 square feet per gallon, one coat.

No. 31.

IMPORTED RED OXIDE OF IRON.

This paint is better known to our old customers as "Williamsport Red." Like No. 16, it has been manufactured by us since 1876, and has the longest records for durability of any oxide paint made. The leading pigment in it is especially prepared for us, and is an imported high-grade natural oxide of iron. The chief vehicle is pure linseed oil. While No. 31 is moderate in price, we have no hesitancy in stating that there is no paint on the market today which will give better protection, regardless of cost.

Iron Oxide has long been considered one of the best inhibitors of corrosion, and careful tests demonstrate that a paint film, the pigment of which consists of this material, is one of the best excluders of moisture, which, of course, is the great agent of corrosion. In other words, practically all paint films are more or less porous. A film of pure linseed oil is highly porous; but the addition of pigments to the linseed oil decreases the porosity. Some pigments are more effective in this than others, and iron oxide is most effective of all. The addition of a small amount of gums to the vehicle also aids the resistance of the paint to the passage of moisture. No. 31 has proven these statements under long practice, and the fact that it has been adopted by over 60% of all the gas companies in the United States for use on their gas holders, proves its high resistance to moisture, and also the long life of this paint under the severest conditions—alternate wetting and drying, and expansion and contraction.

For most locations, we suggest using No. 31 for the shop or *priming* coat. We recommend the use of this paint in preference to a red lead paint for the reasons that No. 31 is easier to apply and remains in better suspension than red lead. It costs less and has greater spreading power than red lead, and will, under usual conditions, give as much protection to the metal as a red lead paint. Owing to the heavy nature of the red lead pigment and its tendency to settle in the package, it makes a very difficult paint to apply, and none but a skilled painter can apply it satisfactorily. A high-grade oxide paint, like our No. 31 which is easy to apply, will, therefore, produce the most satisfactory results in practically all cases.

No. 31 is especially recommended as a *finishing coat* on steel exposed to brine dripping from refrigerator cars, etc.

The Florida East Coast Ry. adopted No. 31 as their shop coat for bridges after long-time exposure tests against several well-known paints, including red lead. Many of these bridges extend over salt water, and are subjected to extremely hard conditions, both from sun and water.

The Pennsylvania bridge, when first erected, was painted with No. 31 and it stood seven years before requiring repainting, when it was given a coat of graphite, and in three years was repainted again.

Kenton Avenue Bridge, Cincinnati, Ohio, built in 1896, was painted with three coats of our No. 31 when built, and the paint kept in good condition for ten years without repainting.

All the bridges of the Indiana Harbor Railroad were painted in 1905 and 1906 with two coats of No. 31.

The Boston & Albany R. R. has specified No. 31 as the shop coat for several bridges, followed by No. 16 Carbon Black.

The United Fruit Co. has purchased many thousand gallons of No. 31 for use on steel located in Central America, where exposure is very severe.

Mr. O. F. Nichols, formerly chief engineer of the New York Bridge Department, when engineer of construction of the Suburban Elevated Railroad, used our No. 31 on all work over the New Haven Railroad tracks. He examined the paint after ten years of exposure, and said:

"Your paint has made a good showing, and I believe it to be the best oxide of iron paint made, and while I am on record as a red-lead advocate, from my experience with each, when doing work for myself, taking cost, covering capacity and durability into consideration, I would give No. 31 the preference."

All of the bridges of the West Shore Railroad were painted with No. 31 in 1888 to 1891, thousands of gallons being used, and in 1905, on many of these bridges, the paint was still in good condition, after fifteen years' wear. The Vandalia Lines, P. R. R., used this paint for years on all their bridges with great satisfaction.

The Pennsylvania Railroad is using No. 31 as the first coat for bridges on several of its divisions.

The Highway Lift Bridge erected by the Pennsylvania Steel Company for the Cape Cod Canal near Bourne, Mass., was painted in the field with No. 31 in 1911.

No. 31 was used as a priming coat under a coat of No. 16 Carbon Black on bridges of the Empire United Rys. during 1913-1914.

The Virginia-Carolina Ry. Co. used No. 31 for retouching their bridges before applying No. 16 on all of these structures in 1913.

The large bridge between So. Wilkesbarre and Plymouth, Pa., was given a coat of No. 31 before using our No. 38 Green Graphite as the finishing coat.

All of the city bridges in Cohoes, N. Y., were painted with two coats of No. 31 in 1910, and are still in excellent condition.

No. 31 is extensively used on large industrial plants throughout the country, including such as The Westinghouse Air Brake Co.; Westinghouse Machine Co.; Westinghouse Elec. & Mfg. Co.; New York & Pennsylvania Co.; West Va. Pulp & Paper Co.; Ontario Power Co. of Niagara Falls; Canadian Niagara Power Co.; Niagara Falls Power Co.; Toronto Power Co.; Anaconda Copper Mining Co.; Garfield Smelting Co.; New York Edison Co.; Edison Electric Illuminating Co. of Brooklyn;

National Malleable Castings Co.; Mineral Point Zinc Co.; Procter & Gamble Mfg. Co.; Garner Print Works & Bleachery; Shepard Electric Crane & Hoist Co., etc.

Many architects and engineers regularly specify No. 31 for the structural steel of office buildings, manufacturing plants, power houses, piers, etc., and it is also extensively used on wooden structures, as for instance, on all of the stations of the Norfolk Southern R. R. Co., where it is the standard station body paint with No. 29 Gray for the interior and trim.

We have already referred to the fact that No. 31 is used on over 60% of all the gas holders in the United States. For this class of work we furnish No. 31 in a special form. Some Gas Companies have used No. 31 Gas Holder Paint continuously for over twenty-five years. We print below a letter received from the Chief Engineer of the Pacific Gas & Electric Co., which is still using No. 31 on all of their work:

"San Francisco, Cal., November 10, 1905.

"We still holders we are now building are one 4,000,000 feet and two 300,000 feet holders, being built by the Davis & Farnum Mfg. Co., of Waltham, Mass., and these holders are painted with your No. 31 Gas Holder Paint, which I specify to your satisfaction on account of its good qualities, and the fact that it has given perfect satisfaction during the thirteen years which I have used it. I will also say that every holder in our system, all previously gas works is being painted with your No. 31 Paint as fast as it is required.

Very truly yours,

E. C. Evans,

Chief Engineer, Gas Dept."

No. 31 will cover from 550 to 850 square feet per gallon, one coat.

GRAPHITE PAINTS.

We manufacture graphite paint in both the natural and other colors, the chief ones of which are:

No. 27 Natural Graphite
28 Green Graphite
34 Graphite and Oxide
36 Graphite and Oxide
64 Acheson Artificial Graphite
700 Graphite and Red Lead

Graphite paints have been extensively advertised and have come to be well known and widely used. Our No. 27 represents the highest grade of paint it is possible to manufacture with graphite pigment. Its vehicle is pure linseed oil with the most pure high-grade special driers. Comparative analysis of the pigment of No. 27 and of the pigments of other well-known graphite paints shows that the pigment of No. 27 is purer than any of the others, and in addition to this the pigment we use is of much finer texture—an important feature which contributes to its greater durability as well as its greater covering capacity.

Graphite paint makes a very good protective coating for metal when used for the final coats over a suitable priming coat. It is not recommended to be used in direct contact with the metal, as it is not an inhibitor of corrosion. No. 31 Red Oxide should be used for the priming coat.

It must be confessed that, as compared with some other pigments, graphite has somewhat disappointed the expectations of paint manufacturers in general, so far as durability is concerned. However, for certain classes of work, such as smoke stacks, bridges subjected to locomotive blasts, etc., excellent results are obtained. We furnish thousands of gallons of graphite paint to railroads and other large consumers, and recommend No. 32 Natural Graphite as the best graphite paint on the market today. We have developed this coating for metal with the same careful study and long experience as our other "Technical Paints for Metal." The American Bridge Co., Pennsylvania Steel Co., Bethlehem Steel Co., Phoenix Bridge Co., Berlin Construction Co., and other bridge and structural concerns purchase large quantities for their work and other prominent users of our graphite paints include:

Alabama & Vicksburg Ry.
Anaconda Copper Mining Co.,
Didier-March Co.
Riter-Conley Mfg. Co.
Marion County (Iowa)—all bridges
Louisville & Nashville R. R.
Garfield Smelting Co. (Utah)
Vicksburg, Shreveport & Pacific R. R.
American Car & Fdry. Co.
Atlas Portland Cement Co.
New York & New England Cement and Lime Co.
Alan Wood Iron & Steel Co.
Vicksburg National Military Park Commission
U. S. Government

Our No. 32 Natural Graphite is usually made from the Mexican graphite pigment, as our tests have proved that for most locations this pigment gives the best results.

We, however, carry regularly in stock in addition to the Mexican graphite, the Acheson artificial graphite pigment, and are prepared to give to our customers their choice of any graphite pigment that can be purchased.

This artificial graphite is made principally from anthracite coal, treated in electric furnaces at a very high degree of heat, and air-floated

Graphite paint will cover from 750 to 850 square feet per gallon, one coat.

No. 250.
PURE BLUE LEAD.

Blue Sublimed Lead is a product obtained by the smelting of non-argentiferous lead ore. Sublimed lead is made in two colors—White, suitable for all purposes that the corroded white lead is used for, and Blue, which is preferable as a paint for iron. They are both prepared in special furnaces, the process is the same in principle as that used in manufacturing oxide of zinc, and the use of "fume" from lead smelting is very old, and is mentioned as far back as 1778.

The chemical composition of sublimed lead is sulphate and anhydrous oxide of lead, both amorphous; there is a small percentage of zinc in the Missouri lead ores, which in the process of smelting is converted into zinc

oxide and is found in the sublimed lead product, and the Blue Lead also contains a percentage of carbon obtained from the fuel used.

In making sublimed white lead, Connellsville coke is used as a fuel, while the blue lead owes its color to the lead sulphide and carbonaceous matter from the bituminous coal used as a fuel in the smelting furnaces. These furnaces are heated to a white heat of 2000 degrees F., which reduces the ore to a fume or vapor; this vapor is blown through a series of chambers and deposits on suspended bags, the dust is then washed and treated and becomes either sublimed white or blue lead, depending mainly upon the fuel used. Being a pyrogenic-formed substance, it is not affected by heat or deleterious gases of the atmosphere or factories, and particularly is not affected by sulphur and carbonic gases which so quickly destroy red lead.

We especially recommend No. 250 for first coating, and No. 31 for finishing coats on copper works, steel coal cars, gas holders, crude oil tanks, tank cars, tank steamers and other locations where subjected to extreme exposure to gases and the weather. As rust does not progress under blue lead, it makes a valuable shop coat paint where the iron or steel is to be shipped a long distance and exposed to abrasions, salt air, gas fumes, etc. On the test fences at Atlantic City, blue lead was shown to be one of the best priming coats and this bears out our own experience with this pigment.

The structural iron work in the Woodbridge Building, New York, is finished with a shop coat and one field coat of our No. 250 Blue Lead, and one gallon on that job covered with two coats over 400 square feet. The large grain elevators at Montreal are finished with blue lead.

No. 250 Blue Lead is displacing red lead as a priming coat for gas holders. Among the large number of plants on which it has been used are holders for the Pacific Gas & Electric Co.; Portland (Ore.) Gas Light Co.; Seattle Lighting Co.; Tacoma Gas & Electric Co.; Western United Gas & Electric Co. (Illinois); Ft. Wayne Gas Co.; New Orleans Lighting Co.; Chattanooga Gas Co.; Atlantic City Gas Co.; Easton (Pa.) Gas Works; Hartford City Gas Lt. Co.; Fall River Gas Co., and others.

Blue lead is furnished by us in paste form or in a mixed state all ready for use, and will cover about 600 to 700 square feet per gallon, one coat.

SUSPENDED RED LEAD.

We manufacture ready mixed red lead paints containing any percentage of red lead desired up to 85 per cent. Our No. 300 Suspended Red Lead is guaranteed to contain a larger percentage of pure red lead than any other ready-mixed red lead paint on the market.

We are constantly testing all of the leading brands of red lead for purity, durability, shade and suspension and in buying No. 300 you are assured of getting the best red lead pigment combined with the purest linseed oil. It is not reasonable to expect good results after mixing dry

red lead by hand for a few minutes. When the order is received we mix it thoroughly by machinery, and guarantee its good suspension, and its easy stirring up for six months after the date of shipment; if found otherwise, it can be returned at our expense.

A large western city which paints most of its bridges with red lead, using it in the natural color for the finishing coat, tried No. 300 on several new bridges. The City Bridge Engineer informed us they are getting much greater durability than with red lead used in the old way and it was for this reason they asked the Bridge Company to use it.

It has been found in the experience of engineers, architects and inspectors even after the greatest care has been exercised, that in specification contract work,—unsatisfactory results are obtained more often with red lead than with any other kind of paint. One of the most noted bridge engineers in the country informed us that while he believed in the durability of red lead, he had given up specifying it because almost all of his red lead jobs turned out poorly.

The experience around New York and Chicago during the past fifteen years, where specifications on a large amount of bridge work called for 33 to 36 pounds of red lead to the gallon of oil has proven the mistake of using so much lead. Most of the bridges were in bad condition after three years, the paint scaling off, and the color, which was originally a medium brown by the addition of lampblack, has faded to a dirty gray. Several of the bridges have been repainted inside of four years but not again with red lead.

The Lehigh Valley R. R. specified No. 300 Suspended Red Lead on a number of new bridges during the past few years, in connection with our No. 401 and No. 400 Carbon Black in the field.

The new coaling pier of the Boston & Albany R. R. in Boston was given a shop coat of No. 300, with No. 16 in the field, on the specification of the railroad's engineering department.

The Eastman Kodak Co. has adopted No. 300 as its standard shop coat on all steel and ironwork used in their buildings.

The structural steel of several piers in New York has been painted with our Suspended Red Lead, and we have also furnished it for similar work in other cities, including Havana, Cuba, and San Juan, Porto Rico.

We also use in combination with red lead other pigments such as carbon, graphite, lampblack, red and brown oxides.

No. 300 Red Lead will cover about 500 square feet per gallon, one coat.

No. 400.

CARBON BLACK.

This paint has well-known records of over twenty-five years' standing, and contains a larger percentage of carbon black than our No. 16. We recommend No. 400 for overhead bridges crossing railroad tracks,

especially where three field coats of paint are to be applied. Where only two field coats are applied we can obtain longer service at a lower cost by using No. 16.

We make No. 400 in three shades:

No. 400—Carbon Black.

No. 401—Dark Brown—Carbon and Oxide.

No. 402—Medium Brown—Carbon and Oxide.

Thus a different color can be obtained, if desired for each coat, as is now quite a common practice among engineers in painting important work.

No. 400 is in use on bridges of the following railroads: Atchison, Topeka & Santa Fe Ry., Lake Shore & Michigan Southern Ry., Chicago Great Western Ry., Chicago, Milwaukee & St. Paul Ry., Cleveland, Cincinnati, Chicago & St. Louis R. R., Chicago, Rock Island & Pacific, Pennsylvania Lines West, Cumberland Valley R. R., N. Y., N. H. & H. R. R., C. C. & O. R. R., Lehigh Valley R. R., Niagara Junction R. R.

On one of these roads a number of bridges directly in the heart of Chicago, where they are subjected to extremely severe conditions, were repainted in 1898 and 1899 with No. 400, and most of them were again painted during 1905, 1906 and 1907, giving No. 400 a record for wear of six to eight years under severe exposure.

No. 400 in the black color is a strong jet black, and when applied furnishes a brilliant lustre which keeps bright for a long time.

No. 400 covers about 850 square feet per gallon, one coat

Nos. 401 and 402 cover 650 to 700 square feet per gallon, one coat.

No. 625.

GALVANIZED IRON PRIMER.

The proper painting and protection of galvanized metal has been one of the most difficult problems for the master painter. Permanent protection is not provided for by the galvanizing process, and painting must be resorted to in order to properly protect the metal. The peculiar, greasy nature of a zinc-coated metal prevents the proper adhesion of ordinary paints, so that peeling and blistering takes place. In order to secure better results, a number of different methods of treatment of the metal are used. These preliminary treatments are unnecessary when the proper paint is used for the priming coat

No. 625 Galvanized Iron Primer is a paint manufactured by us, especially for use on new or old galvanized iron, and will give a coating that is extremely durable, adhering firmly to the metal. We do not know of a single case where No. 625 has peeled or blistered.

The special vehicles of No. 625 Galvanized Iron Primer are acid-proof, and obtain a firm hold on the smooth, greasy surface of galvanized iron. The pigment is principally white lead and special silicious materials of sharp, angular form, which, when applied with a brush, slightly scratch the hard, smooth surface of the metal, and enables the paint to get a firm grip, which the varnish vehicles will retain.

After applying a coat of No. 625, any of our paints can be used over it without fear of peeling; or No. 625 can be used for the finishing coat.

No. 625 GALVANIZED IRON PRIMER is furnished in gray, black, red, brown or practically any color, except pure white, and is suitable for finishing coats as well as for priming. It is especially recommended for finishing coats on buildings which are subjected to fumes that are injurious to linseed oil paints.

It has been used by railroads with success, and is also on a number of large piers over salt water, and we especially recommend it for salt water exposure.

No. 625 comes ready for use, and will cover about 650 square feet to the gallon, one coat.

No. 700.
RED LEAD AND GRAPHITE.

It is well known that a paint made with a combination of pigments is superior in wearing qualities to one in which only one kind of pigment is used. This fact explains why our No. 700 Red Lead and Graphite gives longer service than any straight graphite or red lead paint.

The graphite used in No. 700 is the best and purest that can be obtained, while the red lead is the same as is used in our No. 300 Suspended Red Lead.

No. 700 is recommended for the protection of steel subjected to very damp conditions, such as the lower portions of bridges, pen-stocks, wheel-pits, etc. (See article on "Power Plants" page 35.)

For general bridge painting where a red lead paint is desired there is no paint made based on lead or graphite that will give service equal to No. 700. The L. & N. R. R. painted a sample bridge in 1904 with No. 700, using it as a test against their own hand-mixed red lead, and the record it made was so good that in 1909 and 1910 they ordered 3,200 gallons of it.

In a test of four paints on a bridge of a prominent railroad in the West which hauls many refrigerator cars, one a graphite paint, one a carbon, one a varnish paint, and the other our No. 700, it was found, after five years' wear with no retouching whatever, that No. 700 stood the best of the four, on the floor members which received brine drippings from passing refrigerator cars. We must confess, however, that we have equally as good a report on our No. 31—on a similar test made on a prominent railroad bridge in the East; and the cost of No. 31 is less.

No. 700 will cover about 600 square feet per gallon, one coat.

No. 755.
SUBWAY BLACK.

Within recent years it has been recognized that the final coat of paint on steel which is to be enclosed in concrete, should not contain linseed oil, as lime and alkalies cause saponification of the oil, especially in the presence of moisture.

For this reason we formulated our No. 755 Subway Black, which contains no linseed oil. The vehicle used is especially prepared for this

paint and is not injuriously affected by contact with concrete. This paint is used by a number of engineers and architects, and is highly recommended by us for use as the final coat on structural steel, which is to receive an encasement of concrete. The shop or priming coat should consist of a high-grade inhibitive paint made with linseed oil, such as our No. 51 Williamsport Red Oxide, which is in turn protected from the concrete by a field coat of No. 755. No. 755 is moisture proof, and guards against electrolytic corrosion as it is highly resistant to electric currents.

Among the more important buildings on the steel of which No. 755 Subway Black has been used, is the magnificent Greenbrier Hotel at White Sulphur Springs, W. Va., shown on page 27.

NATIONAL MARINE PAINTS.

We manufacture a full line of Marine Paints, such as our
National Copper Paints—all shades.
National No. 1 Anti-Corrosive.
National No. 2 Anti-Fouling.
National Topping Paints—all shades.
National Yacht White.
National Marine Black.
National Deck Paints—all shades.

WAR DEPARTMENT.

Office of the Chief of Ordnance, Washington, May 14, 1907.

Chemical & Elliot, 198 William Street, New York City.

Gentlemen:

I am instructed by the Chief of Ordnance to enclose herewith a copy of report of the test of the paint therein referred to. A circular letter has been written to the ordnance establishments, authorizing them to consider your No. 42 gray graphite in competition with other paints for use on seacoast guns. It is, of course, understood that the paint they are authorized to consider shall be the same as that tested.

Very respectfully,

(Signed) Lawson M. Fuller, *Major, Ord. Dept., U. S. A.*

For the past seven years, we have sold the U. S. Government thousands of gallons of Sea Coast Gun Paint.

UNITED RAILWAYS OF HAVANA TERMINAL STATION.

Kenneth R. Murchison, Architect. Erected by Snare & Triest Co. 1911. Cheesman & Elliot's paints in various shades used on the structure, which cost about $3,000,000.

STRUCTURAL STEEL PAINTS.

The proper painting of the structural steel of large buildings is an important matter, and many engineers and architects are regularly specifying "Cheesman & Elliot's" protective paints for this class of work.

In the majority of cases No. 31 Red Oxide (page 40) is used as the shop coat, and followed in the field by one or more of the following: No. 16 Carbon Black (page 37), No. 54 or No. 56 Oxide and Graphite (these paints are practically identical with No. 31, except for the addition of sufficient graphite to give a distinguishing color. See page 42), No. 92 Natural Color Graphite (page 42), or No. 755 Subway Black (page 47). Also see sample specifications on pages 9 and 10.

Our No. 300 Suspended Red Lead (page 44) is also specified to a considerable extent for shop coats where it is desired to use this pigment.

Our first recommendation for the field coat is No. 16, excepting where the steel is to be enclosed in concrete, when No. 755 Subway Black should be used as the final coat.

For three-coat work No. 54 or No. 56 are suggested as the intermediate of first field coat.

Among the large structures on the steel of which our coatings have been used are:

Fischel Building, 23rd St., Kinsella Apartment Houses, 122nd & Riverside Drive; Hall Apartment House, 90th St.; Twin Apartment

Houses for Carlysle Realty Co., 110th St.; Carnegie Apartment Houses, 111th St.; Loft Building for Lordi & DeRespiris Construction Co., 13th St. & Fourth Ave.; Substations of the New York Edison Co. on 26th, 41st, 84th and 140th Streets, and on Hunts Point Road; Fifth Avenue Building, 23rd St. & Fifth Ave.; Neptune Building, E. 27th St.; Office Building on Fourth Ave. & 18th St.; J. M. Horton Building, 24th St.; Two Apartment Hotels on W. 72nd St.; Apartment House on Park Ave.; Loft Building, 45th St.; Second Avenue Car Barns; Strand Theatre and Office Building, Broadway & 47th St.; Brooklyn Trust Co. Building, all in New York City.

Public Schools of New York City and Chicago, Ill.; Southern Railroad Office Building, Washington, D. C.; Depew Place Wing of Grand Central Terminal, New York; N. Y. C. & H. R. RR. Car Sheds, West Albany, N. Y.; Plants of, General Electric Company, Lynn, Mass.; Factory of American Ever-Ready Company, Long Island City; Gregg Company, Lodi, N. J.; Atlas Portland Cement Company; Hershey Chocolate Company, Hershey, Pa.; Westinghouse Air Brake Co.; Farrel Foundry & Machine Co., Ansonia, Conn.; Pennsylvania Water & Power Co.; Harlan & Hollinsworth Co., Wilmington, Dela.; Alsens Portland Cement Co.; Alan Wood, Iron & Steel Co.; Anaconda Copper Mining Co.; Garfield Smelting Co.; Orford Copper Co.; Ducktown Sulphur, Copper & Iron Co.; Tennessee Copper Co.; Didier-March Co.; Eastman Kodak Co.; Ulster Iron Works, Dover, N. J.; Lehigh Navigation & Electric Co., Hauto, Pa.; Niagara Falls Power Co.; Ontario Power Co.; Toronto Power Co.; Canadian Niagara Power Co.; Goff Building, Clarksburg, W. Va.; Union Station, Havana, Cuba; White Building, Seattle; Court House, Schenectady; Court Building, Nashville; Chicago Post Office; Wellington Building, Boston; Woodbridge Building, New York; Savoy Hotel, New York; Corn Building, New York; Goelet Building, New York; Frankel Building, New York; Ferry House, 39th St., Brooklyn (Dept. of Docks & Ferries of New York City); Boston & Albany R. R. Pier, Boston; Palais Royal Building, Washington, D. C.; Theatre Building, Providence, R. I.; Car Barns of Springfield Railways Co., Springfield, Ohio; Greenbrier Hotel, White Sulphur Springs, W. Va.

NaPaWork INTERIOR FLAT FINISHES and "SUN-WITE" MILL ENAMEL.

NaPaWork Flat Finishes dry without gloss and produce a soft-tone coating of great durability, which can be easily cleaned by washing. They are furnished in all colors and by a proper selection, artistic, warm effects are obtained on walls, ceilings, etc., of office buildings, hotels, hospitals, schools and residences.

As the cost of NaPaWork Flat Finishes is moderate, they are extensively used also in industrial plants of all descriptions, especially No. 57

NaPaWork Flat White. We quote the following extracts from an article entitled "Cutting Factory Costs," in the November, 1912, issue of "System":

"WHITE PAINT ECONOMICS

"Repeated tests have shown that white paint and white paper will reflect approximately eighty per cent. of the light which strikes its surface. A plain unpainted board wall will reflect only about twenty per cent. Dark walls, such as may be covered with dirt, dust, oil or dark paint will reflect but four or five per cent. of the light which strikes them. *The difference in the amount of light reflected in a factory with white walls and ceiling and one with dark walls, may be as much as seventy-five per cent.* Many manufacturers go to great expense to increase their illumination ten or twelve per cent. by additional lights and fixtures when much better results could be obtained by using white paint on the factory wall and ceilings. White paint has been found to be not only less expensive than the installation and maintenance of more artificial illumination, but its reflecting coat will give tone to the whole building.

"In one small plant four or five years ago, for instance, it was noticed that after the inside had been painted, the average length of a working day, during which no artificial illumination was required, was increased by one and one-half hours. It was further noted that the electrical power required gave the same illumination when decreased one-third. Either of these savings was more than sufficient to pay for the painting of this building during the first year.

"In one or two shoe factories equally good results were obtained. As an experiment, one part of a room was painted white. The contrast was remarkable. Workmen in the unpainted section requested that their part be painted. The new paint seemed to more than double the light. The operatives then noticed the windows were dirty and requested that they be kept clean. All this not only decreased the amount of light needed during artificial lighting hours, but also decreased the length of time that artificial light was required.

"Another marked effect of white paint in this case was to improve to a considerable extent the illumination on the machines from all directions. Before the white paint was put on practically no light was reflected from the walls, ceilings or posts, and the machines received light from but one direction. But the white paint largely eliminated shadows and brought about a general increase in the amount of work done and an improvement in its character.

"White paint, like light, has a police value in the factory. If you have a dark corner that is always dirty, paint the walls white."

Progressive concerns recognize not only the importance of interior white paints, but also the economy of using a durable paint that can be kept bright and clean by washing. No. 57 is suitable for use on brick, concrete and plaster, as well as wood and metal, and is recommended as the highest grade interior white paint on the market. As it has no gloss, there is no glare or reflections to try the eyes.

Where a gloss white finish is preferred, our "Sun-Wite" Mill Enamel is recommended. Like No. 57 Flat White, "Sun-Wite" Mill Enamel is permanent in whiteness, and this is a feature lacking in some of the so-called similar paints on the market. For specifications see page 10.

Among the large users of our interior white coatings may be mentioned the West Virginia Pulp & Paper Co. (several mills), New York & Pennsylvania Co. (several mills), Highland Paper Co., Shepard Crane & Hoist Co., Westinghouse Machine Co., Westinghouse Air Brake Co., Westinghouse Elect. & Mfg. Co., Garner Print Works & Bleachery, General Electric Company, etc.

N. P. W. PREPARED PAINTS FOR BUILDINGS, STATIONS, FREIGHT CARS, ETC.

Our standard prepared paints for wooden structures are made of the best and purest pigments with the necessary coloring matter, ground and thinned with only pure linseed oil and the necessary driers. The

proportions of the mixtures are scientifically adjusted to suit the conditions of each job in accordance with our custom of making everything to order.

We furnish large quantities of these paints for railroad stations, industrial plants, company houses, etc. The Norfolk Southern Railroad has adopted our No. 31 as their standard exterior station paint, and No. 20 for the interiors. The National Railways of Mexico adopted Nos. 18 and 20, and among the other railroads using our station paints, the United Railways of Havana purchase thousands of gallons each year.

SPECIFICATION PAINTS.

Another large department of our business is the manufacture of paints on specifications furnished by our customers. We are equipped to furnish promptly paints made in strict accordance with any specification for any kind of work, and are making daily shipments of specification paints to railroads and other customers.

ELEVATED RAILWAYS.

With but one exception, we have supplied paint for every elevated railroad structure in the United States. During 1905-1906 we furnished over 20,000 gallons to the Brooklyn Elevated and in 1914 it had not been repainted.